DOCUMENT RESUME

ED 097 028 IR 001 215

AUTHOR	Demb, Ada Barbara
TITLE	Instructional Uses of Computers in Higher Education: A Survey of Higher Education in Massachusetts.
INSTITUTION	Harvard Univ., Cambridge, Mass.
PUB DATE	Oct 74
NOTE	14p.; Paper presented at the EDUCOM Fall Conference (Toronto, Ontario, October 16-18, 1974)
AVAILABLE FROM	Proceedings of the EDUCOM Fall Conference, EDUCOM, Rosedale Road, P. O. Box 364, Princeton, New Jersey 08540 (Estimated price, $6.00 for member institutions; $12.00 for others).
EDRS PRICE	MF-$0.75 HC-$1.50 PLUS POSTAGE
DESCRIPTORS	Business; *College Curriculum; Colleges; *Computer Assisted Instruction; Computer Oriented Programs; Games; *Higher Education; Mathematics; Physical Sciences; Problem Solving; Simulation; Social Sciences; *Surveys; Teaching Methods; Tutoring; Universities
IDENTIFIERS	Massachusetts

ABSTRACT

A survey of computer use was conducted in 1974 in a small, nonrandom sample of Massachusetts colleges and universities. Allowing for inflation, but adjusting for the increase in computer power per dollar, it is clear that significantly more computer power is being devoted to instruction--both "with" and "about" the computer. The percentage of computer-using courses teaching "with" the computer is estimated to be about 70 to 75 percent of the total number of courses using computers. In particular, physical sciences, social sciences, business, and mathematics have increased their computer use. The bulk of the application is in drill and practice, problem-solving, games, and simulations. Each of these applications is found in most of the departments reporting use of the computer. By contrast, there are very few instances of tutorial or inquiry and retrieval uses. (Author/WCM)

ED 097028

Instructional Uses of Computers in Higher Education

A Survey of Higher Education in Massachusetts[1]

Ada Barbara Demb

Harvard University

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION
THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL NATIONAL INSTITUTE OF EDUCATION POSITION OR POLICY

In the spring of 1974 in conjunction with the larger research project then being conducted by Professors Rockart and Morton, John Reid and I conducted a survey of computer use in colleges in Massachusetts. Prior to this study, the latest comprehensive data seemed to date from two studies conducted in 1969, and 1967 by G. A. Comstock. We were interested in discovering the level of current computer use, and the nature of present instructional endeavors.

Our survey looked at all colleges in Massachusetts which were four year institutions and which offered a bachelor's degree or higher. Of the 78 such schools we talked personnally with instructors and computer staff at all but five. Three-quarters of those schools were using computers in one way or another and more than half used computers in instruction.

Albeit the distribtuion of institutions in Massachusetts differs from the national profile suggested by the 1967 data, in that there are proportionately more doctoral research institutions, we feel that this does not generally affect the usefulness of the data in putting together a picture of current usage. When appropriate in the course of discussion, biases will be noted. Several general questions were examined and trends were identified where possible.

---

[1] A detailed description of this research project appears in Computers and the Learning Process in Higher Education, by John Rockart and Michael Scott Morton (A Report Prepared for the Carnegie Commission on Higher Education, published by McGraw-Hill), in press, October 1974. Chapter 7.

R001215

I. What is the general level of computer use and how are schools setting priorities with regard to expenditures for research, administration and instruction?

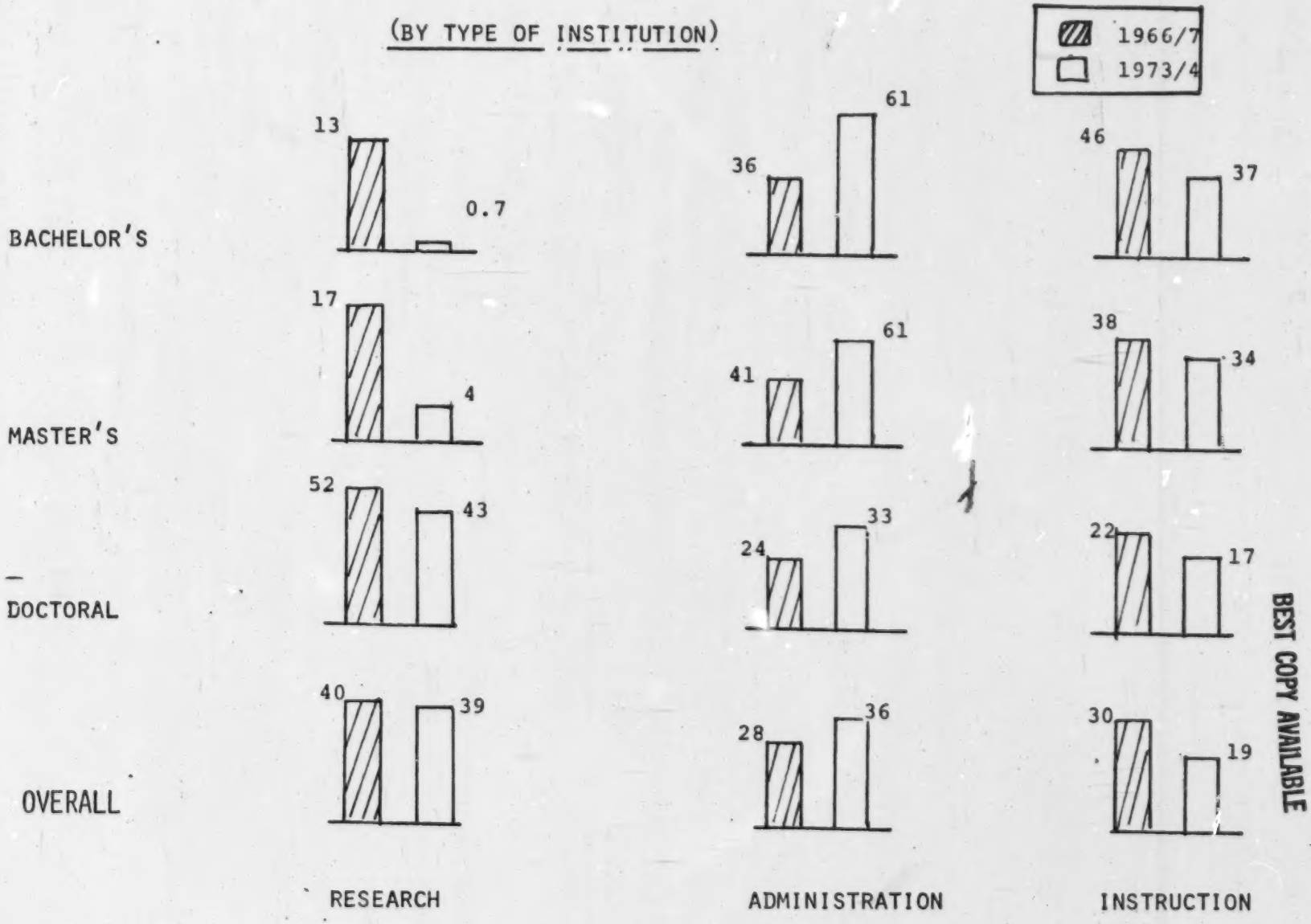
We found very few general institutions who were not making some use of the computer. Since 1969 the smaller general institutions offering a master's degree or less have caught up to the larger institutions in terms of access. In addition to the increase in the use of smaller and cheaper mini-computers, the availability of large-scale computers to smaller groups of users through time-sharing networks and other administrative arrangements has been effective in making this widespread availability possible. In 1967, the national study revealed that only 39 percent of the institutions of higher education in the country were making any use of the computer. In 1974 in Massachusetts the percentage was 75. Our data suggests also that further growth will probably not take place by introducing computers into institutions formerly having no computer. Instead, growth will come from new applications and new equipment for institutions already familiar with the technology.

The Overall row in Figure 1 shows a striking decrease in the portion of computer expenditures being allocated to instruction. The column to the far right shows institutions at every degree level -- bachelor's, master's, and doctoral -- experienced a decrease in the instructional portion of their computer expenditures. We explored two possible sample biases: 1) the presence of large research institutions in Massachusetts, and 2) the predominance of doctoral institutions who may spend smaller portions of budgets for instruction. In the first instance, Figure 1 illustrates that this portion of the budget has declined for institutions granting degrees at all levels.

FIGURE 1

CHANGES IN ALLOCATION OF DOLLARS FOR RESEARCH, ADMINISTRATION, INSTRUCTION

(BY TYPE OF INSTITUTION)



BEST COPY AVAILABLE

In the second matter, the national survey reported about the same percent of their total expenditures coming from doctoral institutions as we found in Massachusetts. The data thus suggest that this decline in research reflects the dramatic decrease in the availability of foundation and federal funding for research and instruction, as well as the increase in need for administrative effort which occurred as financial control became increasingly more important during the period 1967 to 1974. Clearly, much greater portions of total institutional budgets at all degree levels are being allocated to administrative applications.

It should be noted also that in 1966 a report of the National Academy of Sciences (NAS, 1966) found that about 20 percent of the total computer expenditures were being allocated to instruction at that time, and they predicted that this portion would decrease. Comstock's survey of California indicated that instruction comprised 27 percent of institutional budgets in 1968-69. The Massachusetts percentage reflects a clear decline.

II. <u>What does this decrease in instructional expense mean for academic use? Are there fewer resources available</u>?

Although the numbers may appear deceptive, the answer is no. The 1967 report of the President's Science Advisory Committee recommended an average student expenditure of $60 for instructional uses of the computer. Our data show that on average the expenditure per student for instructional computer uses in 1974 was about $17, apparently far less than the goal of $60. However, if one takes into account the increase in computer power per dollar of hardware expenditure -- which has roughly doubled each year -- and applies

this to the hardware segment of expenditures (about one-half total), and further adjusts for inflation, today's $17 provides much greater computer power than the $60 per student level requested by PSAC could provide in 1967.

It is also interesting to note here, the numbers of students who make use of the computer. Our data suggest that the number of students in courses using the computer nationallyhas increased four-fold since 1967.[2]

III. What is the nature of computer use in instruction?

In discussing the use of computer instruction in higher education, we find it useful to distinguish between two distinct types of application. The first, instruction about the computer, involves the part of the university curriculum that deals with the various aspects of computer technology itself. Computer science courses and programming courses fall in this category as do many other courses. The second application, which we call instruction "with" the computer, involves use of the computer as an aid to instruction in courses in all disciplines.

In Massachusetts we found that courses about the computer represented 43 percent of instructional expenditures, and courses "with" the computer represented 57 percent, a clear majority. Earlier studies presented on qualitative statements in this area and they reported that far more of the total expenditures were devoted to instruction about the computer than with. Our data show the reverse now to be true. In fact, the financial figures understate the shift to instruction "with" the computer. As a percent of courses using the computer, about 70 percent are instruction "with" the computer.

The discrepancy between the percentage of expenditure and the percentage of courses with respect to courses "about" the computer represents the nature

---

[2]Such extrapolations are based on Massachusetts student population as 4% of national, and instutional population as 3%.

of the programming involved. These courses generally involve simple program debugging at a continuous, high rate over the course of a semester.

IV. How is the computer used to aid in instruction? Courses "with" computers.

In our survey of the colleges in Massachusetts, each institution was asked to provide a list of courses using the computer and we categorized the courses into five areas:

1. tutorial - CAI, programmed instruction, etc.
2. drill and practice - using the computer to try out or to become more skilled at concepts and techniques learned from another source.
3. problem-solving - using the computer as a calculator or data analyzer.
4. simulation and games - constructing models to gain insight about real-world phenomenon, and/or using these models for competition. (These were separate categories in the original report.)
5. inquiry/retrieval - accessing data bases.

As is shown in Figure 2, the primary use of the computer is in problem-solving, followed by drill and practice and then simulations/games. We found almost no inquiry and retrieval and very few tutorial applications as we have defined them here. In fact we found only three cases of tutorial: two as remedial instruction, and one which prepared students for a state licensing exam. We found only two instances of inquiry/retrieval; these results from a total of 1200 courses. As can be seen from the graph, drill and practice, problem-solving, games and simulations comprise 96 percent of all use of the computer as an instructional aid.

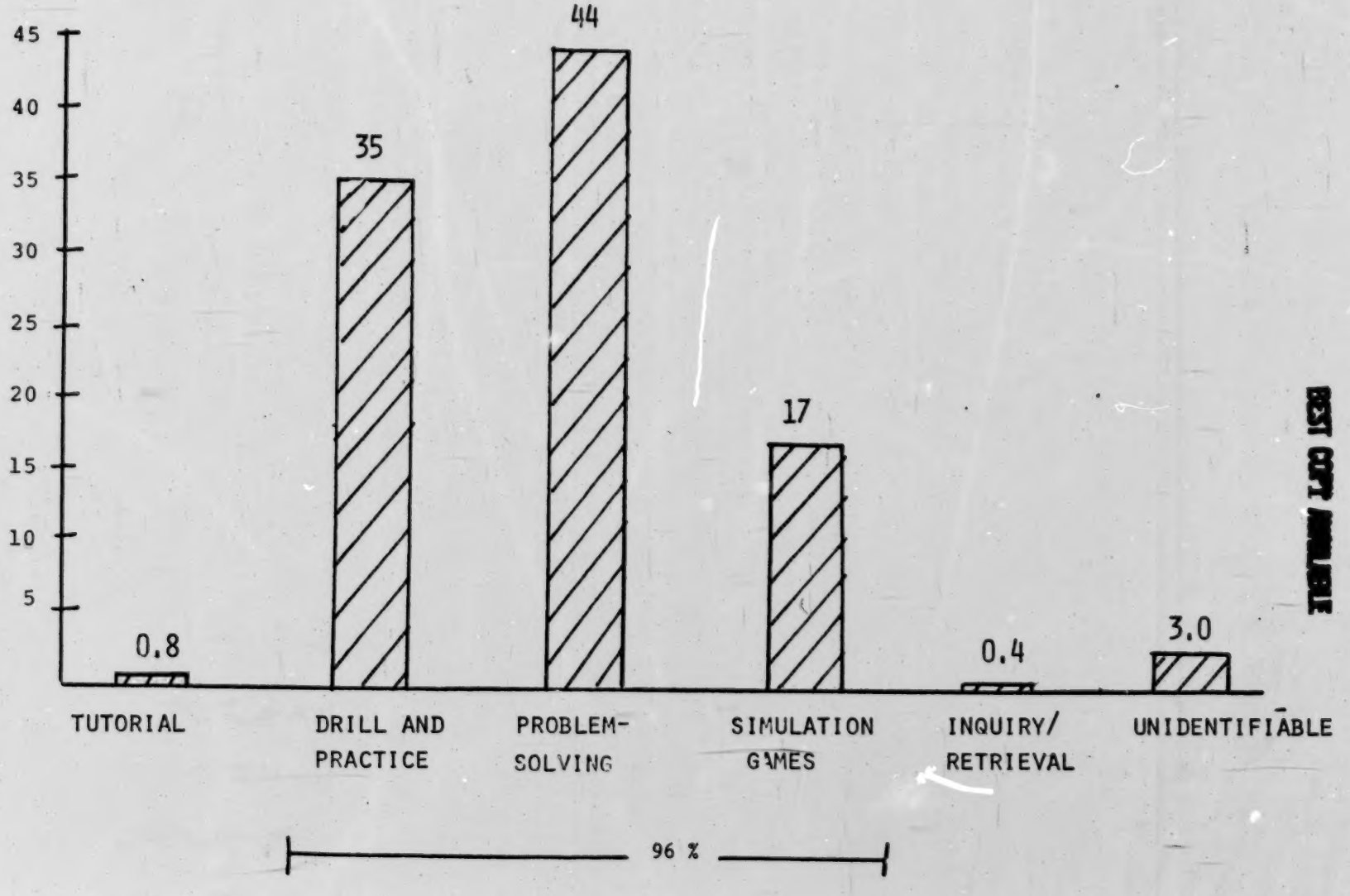
V. Who are the principal users of computers as aids to instruction?

Figure 3 shows relative use by academic field. The graph shows use as a percent of courses "with" computer aid, therefore computer science does not appear.

FIGURE 2

TYPE OF COMPUTER USE:

AS PERCENT OF ALL COURSES "WITH"

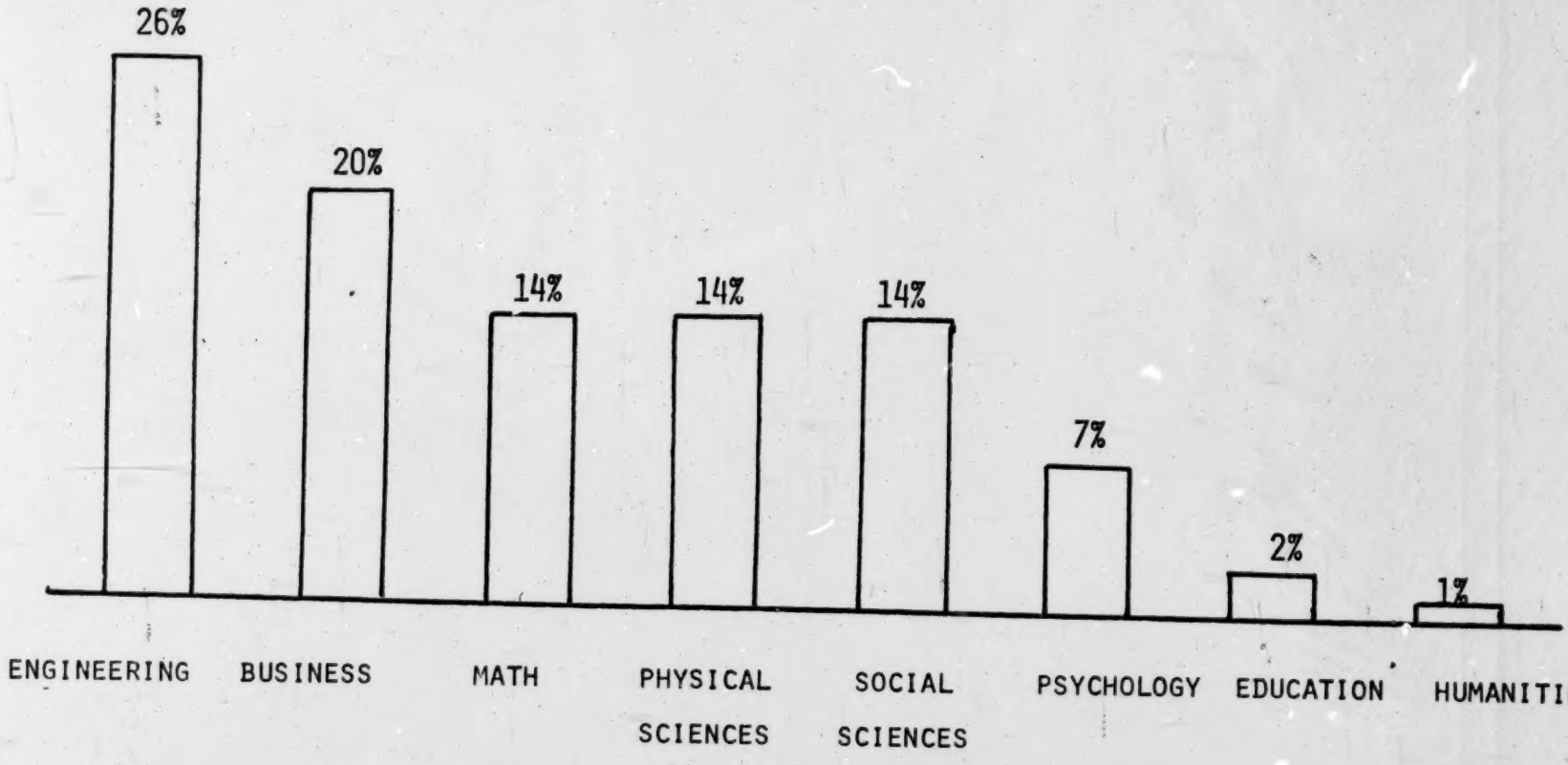


BEST COPY AVAILABLE

FIGURE 3

COMPUTER USE BY ACADEMIC FIELD

AS PERCENT OF TOTAL COURSES "WITH"



BEST COPY AVAILABLE

Engineering is the major user, followed by business, mathematics and the physical and social sciences. The ordering of disciplines has not changed during the past several years although the magnitude of use in certain disciplines, particularly business, the social sciences, psychology and education has increased significantly.

The percent of students in the fields has shifted somewhat, however. As Table 1 illustrates, the greatest shift has occurred in engineering, computer science, business and mathematics. The decrease in numbers of engineering students reflects the absolute decline in engineering enrollments during the past several years. The increase in business is due both to increases in enrollment in this field and dramatic new developments in computer applications.

There has also been a relative decline in the number of courses offered in computer science. However, even though computer science has relatively fewer students, its proportion of the total instructional budget has remained constant. This suggests that the new applications being utilized in business and social science courses tend to be less expensive in any given course than in older computer-utilizing fields such as math and computer science. This hypothesis is confirmed by the data in the third and fourth columns of Table 1 which shows the average expenditure per student for each academic field, 1973-74, compared with the data from the national (SREB) survey of 1966-67. Current data indicate that cost per student in social science and in psychology is less

TABLE 1

SHIFTS IN DISTRIBUTION OF STUDENTS AND STUDENT COSTS

BY ACADEMIC FIELD

FIELD	% STUDENTS		AVERAGE COST/STUDENT	
	1967	1974	1967	1974
ENGINEERING	35	17	52	113
COMPUTER SCIENCE	22	9	81	195
BUSINESS	23	34	60	36
MATHEMATICS	4	12	252	93
PHYSICAL SCIENCES	5	8	109	49
SOCIAL SCIENCES	3	9	69	43
PSYCHOLOGY	1.5	2	126	15
EDUCATION	2	1	91	26
HUMANITIES	0.4	0.2	92	99

than half the cost in engineering, mathematics, and computer science. It also indicates a large decrease in cost per student in mathematics relative to computer science and engineering. The decrease in mathematics expenditures may be due in part to a reorganization of computer science as a separate department. It may also reflect a phenomenon common to all disciplines -- increasing student exposure to marginally inexpensive applications.

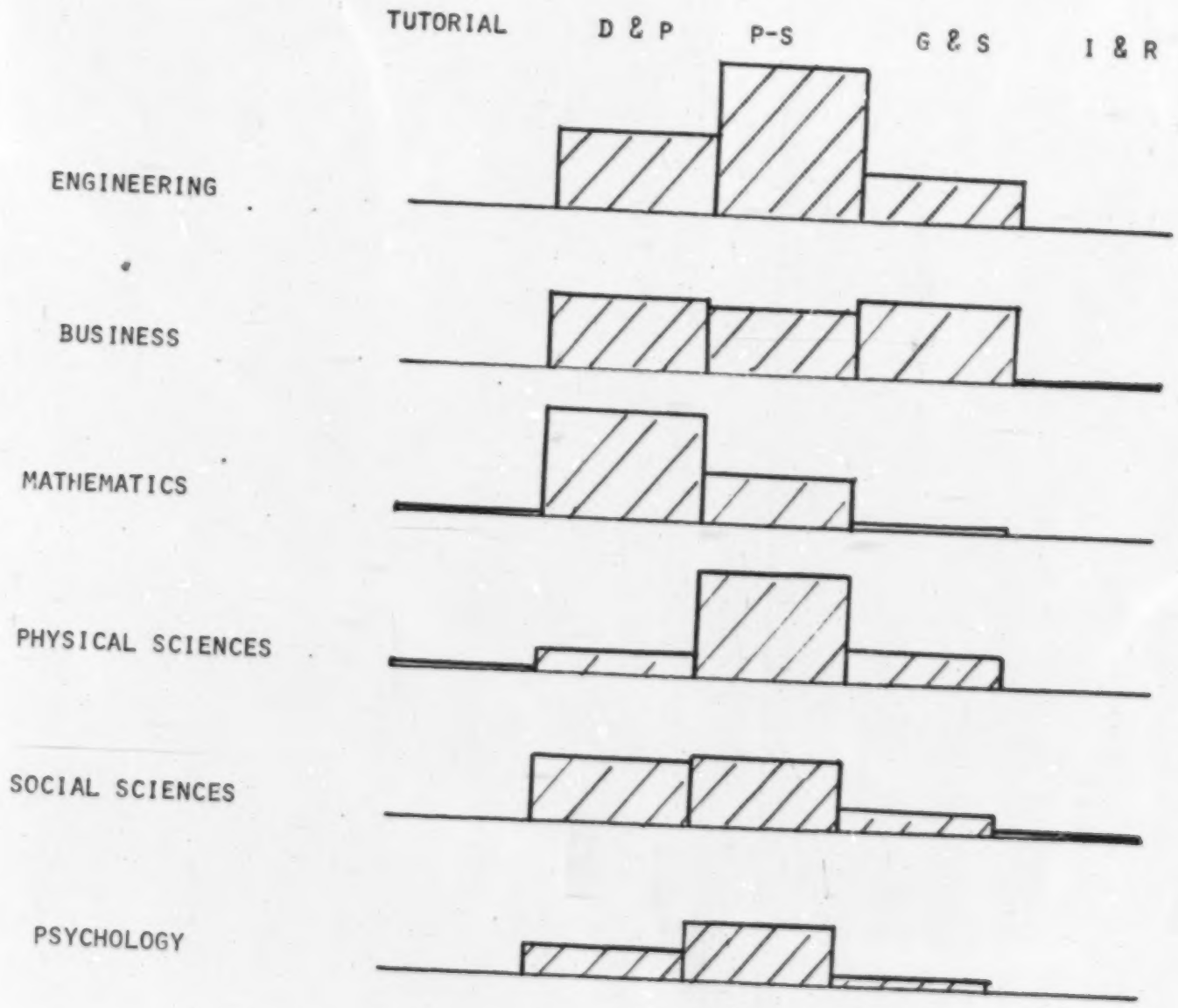
Figure 4 identifies the principal users and types of application. Examining the dispersion of computer applications across academic fields, we find that drill and practice, and problem-solving both share a universality of sorts; almost every field made use of both types of applications. In the social sciences and psychology drill and practice and problem-solving applications primarily represent use in statistics courses and for practice in econometrics.

It is also interesting to note the apparent universality of games and simulations. These applications ranged from the very sophisticated business, legal and environmental games/simulations to the very practical applications: one school where an electron accelerator was not accessible, developed a simulation of this machine.

Growth in the use of the computer in instruction has been characterized by high activity levels outside of computer science and engineering, with relative declines in use being evident in these latter disciplines. Most students involved in instruction "with" the computer use it to reinforce concepts, to practice skills (drill and practice), and as an aid in problem-solving. These applications are evident in almost all disciplines using the computer.

FIGURE 4

TYPE OF COMPUTER USE BY ACADEMIC FIELD



BEST COPY AVAILABLE

VI. Conclusions

The institutions surveyed in Massachusetts in 1974 represent a small, non-random sample of American colleges and universities. Extrapolating from this sample to a description of all four-year institutions in the United States is a considerable jump and tempers the absolute accuracy of the data. However, with this in mind we find four major trends which are evident:

High Growth. The use of the computer in higher education has grown rapidly over the past seven years, with administrative uses of the computer growing fastest of all. Nationally a conservative estimate of this seven-year growth is an annual rate of about 16 percent. In instruction, the number of students who are being exposed to the computer through courses has grown during the same period at a rate more than 20 percent per year. Allowing for inflation, but adjusting for the increase in computer power per dollar, it is clear that significantly more computer power is being devoted to instruction -- both "with" and "about" the computer.

More Teaching "With" the Computer. The percentage of computer-using courses teaching "with" the computer is estimated to be about 70 to 75 percent of the total number of courses using computers. There is an evident swing from the use of computer primarily as a tool to teach "about" the computer to teaching "with" it.

Greater Dispersion of Courses across Academic Fields. In particular, physical sciences, social sciences, business, and mathematics have increased their share of the use.

Bulk of Application: Drill and Practice, Problem-Solving, Games/Simulations. Each of these applications was found in most of the departments reporting use of the computer. By contrast, there were very few instances of tutorial or inquiry/retrieval uses.

References

Comstock, G. A., 1971. "The Computer and Higher Education in California," in R. E. Levien, The Emerging Technology, (McGraw-Hill Book Company, New York) pp. 195-249.

Comstock, G. A., 1971. "National Utilization of Computers," in R. E. Levien, The Emerging Technology, (McGraw-Hill Book Company, New York) pp. 129-194.

National Academy of Sciences, National Research Council, 1966. Digital Computer Needs in Universities and Colleges, Washington, D.C.

President's Science Advisory Council, 1967. Computers in Higher Education U.S.G.P.O., Washington, D.C.